

FUEL INJECTION DEVICE WITH A 3/3-WAY CONTROL VALVE FOR
INJECTION COURSE SHAPING

[0001] Prior Art

[0002] The invention is based on a fuel injection device as generically defined by the preamble to claim 1. In a fuel injection device of this kind, known for instance from German Patent Disclosure 100 39 215 A1, the nozzle needle of a fuel injection valve is opened or closed as a function of the pressure prevailing in a control chamber. The control chamber, connected permanently to the high-pressure side, can communicate with the low-pressure side by means of a 2/2-way control valve embodied as a double seat valve and can thereby be pressure-relieved. However, in this fuel injection device, injection course shaping is not possible.

[0003] Advantages of the Invention

[0004] The fuel injection device of the invention having the definitive characteristics of claim 1 has the advantage over the prior art that the pressure prevailing in the control chamber is suppressed variously quickly by activation or deactivation of the outlet throttle, and injection course shaping can therefore be performed.

[0005] Further advantages and advantageous features of the subject of the invention can be learned from the description, drawing and claims.

[0006] Drawing

[0007] Two preferred exemplary embodiments of the fuel injection device of the invention, with a 3/3-way control valve designed as a double seat valve, are schematically shown in the drawing and explained in further detail in the ensuing description. Shown are:

[0008] Fig. 1, the fuel injection device of the invention, with a double seat valve, which controls the pressure in a control chamber, in its upper valve position;

[0009] Fig. 2, the double seat valve of Fig. 1, in its middle valve position;

[0010] Fig. 3, the double seat valve of Fig. 1, in its lower valve position;

[0011] Fig. 4, the fuel injection device of Fig. 1, with one additional inlet throttle.

[0012] Description of the Exemplary Embodiments

[0013] The fuel injection device 1 shown in Fig. 1 is typically used in an internal combustion engine having a plurality of cylinders, with one fuel injection valve (injector) assigned to each of these cylinders. This injector, in a manner known per se, has an injection nozzle, not shown here in detail, that protrudes into a cylinder combustion chamber of the engine, and a nozzle needle 3, here suggested by only a small part of it, that opens and closes the injection nozzle as a function of the pressure in a control chamber 2.

[0014] The control chamber 2 is permanently connected via an inlet throttle 4 to a high-pressure inlet line (high-pressure side) 5. For controlling the injection event, a 3/3-way control valve 6 in the form of a double seat valve is provided, which opens or blocks the communication of the control chamber 2 with a low-pressure outlet line (low-pressure side) 7. The high-pressure inlet line 5 may communicate with a high-pressure reservoir (common rail), not shown, and the low-pressure outlet line 7 may communicate with leak fuel. An outlet throttle 8 is located in the low-pressure outlet line 7.

[0015] The control valve 6 has a valve body 9, embodied as a valve ball, which is axially adjustable in a valve chamber 10 between two coaxial, annular valve seats 11, 12, by means

of an actuator 13, for instance a piezoelectric actuator. The lower valve seat 11, in terms of Fig. 1, is provided between a first outlet conduit 14 of the control chamber 2 and the valve chamber 9, and the upper valve seat 12 is provided between the valve chamber 9 and the low-pressure outlet line 7. The valve chamber 9 is permanently connected to the control chamber via a second outlet conduit 16 that has an outlet throttle 15; the outlet throttle 15 on the high-pressure side has a greater throttle resistance, for instance a smaller throttling opening, than the outlet throttle 8 on the low-pressure side. By means of the actuator 13, the valve body 9 can be displaced into an upper, middle, or lower valve position.

[0016] In the upper valve position, shown in Fig. 1, of the valve body 9, the valve opening of the upper valve seat 12 is closed by the valve body 9, and the valve opening of the lower valve seat 11 is open, so that the communication of the control chamber 2 with the low-pressure side is blocked. The high pressure that prevails in the control chamber 2 engages a control face 17 of the nozzle needle 3 that acts in the closing direction of the nozzle needle 3, so that the nozzle needle 3 and the fuel injection valve are closed.

[0017] In the middle valve position shown in Fig. 2, the valve body 9 is located between two valve seats 11, 12, so that the valve openings of both valve seats 11, 12 are open. The control chamber 2 communicates with the low-pressure outlet line 7 via both outlet conduits 14, 16, so that the pressure prevailing in the control chamber 2 is lowered, and the nozzle needle 3 and the fuel injection valve open. Because of the outlet throttle 15, the pressure suppression from the control chamber 2 into the valve chamber 10 is effected primarily via the first relief conduit 14, so that the speed of pressure suppression is determined primarily by the outlet throttle 8 on the low-pressure side.

[0018] In its lower valve position shown in Fig. 3, the valve body 9 closes the valve opening of the lower valve seat 11, and as a result the pressure suppression from the control chamber 2 into the valve chamber 10 is effected solely via the second relief conduit 16. The pressure

suppression speed is determined primarily, because of its greater throttle resistance, by the outlet throttle 15 on the high-low-pressure side.

[0019] Since the pressure prevailing in the control chamber 2 is suppressed variously quickly in the middle and lower valve positions of the valve body 9, it is possible, by a suitable combination of the two outlet throttles 8, 15 and the inlet throttle 4, to establish a desired injection course shaping by means of the control valve 6.

[0020] The variant shown in Fig. 4 differs from the fuel injection device of Fig. 1 in that the first outlet conduit 14 is connected directly to the inlet line 5 via a further inlet throttle 18. In the lower and middle valve positions of the valve body 9, this inlet throttle 18 acts as a bypass. In the lower valve position of the valve body 9, the inlet throttle 18 acts in series with the outlet throttle 15 on the high-pressure side, and as a result this outlet throttle can be adapted very finely to the two inlet throttles 4, 18. At the transition of the valve body 9 to its upper valve position, the inlet throttle 18, since the pressure in the first relief conduit 14 is suppressed more slowly, exerts an additional closing force in the direction of the first valve position, so that the control valve 6 closes faster.